SUMMARY LISTING OF LICENSING BASIS DISCREPANCIES AND ISSUES
RELATED TO THE OCONEE TORNADO MITIGATION CAPABILITY
DOCKET NOS. 50-269, 50-270, AND 50-287
(TAC NOS. MB5361, MB5362, AND MB5363)

A. **Licensing-Basis Tornado mitigation issues and discrepancies that were identified during review of the June 7, 2002, amendment request, as supplemented by letters dated January 29 and June 18, 2003:**

(1) Standby Shutdown Facility (SSF) Allowed Outage Time

The current 45-day allowed outage time (AOT) for the SSF failed to consider the current role of the SSF that is credited for tornado mitigation and therefore, the 45-day AOT has not been adequately justified and should be reconsidered.

(2) Unprotected Main Steam Lines

Because the main steam lines outside containment are not fully protected from tornadoes and the Oconee units do not have main steam isolation valves, multiple failures of the main steam lines could occur as a consequence of tornado-induced damage to the shared turbine building and enclosed main steam lines. Failure of the main steam lines due to a tornado could result in excessive steam generator (SG) tube stresses and an unanalyzed radiological release to the environment via the shared turbine building. [See related discussion in A(3) and B(6)]

(3) Impact of HPI Makeup on SG Tube Stresses

When relying on the station auxiliary service water (ASW) system for secondary side heat removal (SSHR) in accordance with existing licensing-basis criteria, high pressure injection (HPI) pump makeup to the reactor coolant system (RCS) is relied upon to prevent exceeding SG tube stresses. Because HPI is not an assured means of providing reactor coolant makeup following a tornado, SG tube ruptures and unanalyzed radiological releases are a potential consequence of a tornado. [See related discussion in A(2) and B(6)]

(4) Pressurizer Safety Valve and PORV Failure Considerations

When relying on the station ASW system for SSHR in accordance with the existing Oconee licensing basis, the licensee relies upon the pressurizer Power-Operated Relief Valve (PORV) and safety valves to relieve RCS pressure while making the necessary preparations for using the station ASW system. During this evolution, there is some likelihood that the pressurizer PORV and/or safety valves will stick open resulting in a small break loss-of-coolant accident (LOCA).

+ The actuators of the PORV and PORV block valve (which would be relied upon to isolate a failed open PORV) are not QA-1 and control power to the actuators is not tornado protected.

+ The pressurizer Code safety valves could be challenged multiple times, passing hot liquid reactor coolant during the later stages of this event scenario. Although the

licensee believes that the probability of the pressurizer Code safety valves failing open during these multiple actuations is on the order of 0.1, this relatively low failure probability has not been justified and is inappropriate. It is not clear why the licensee did not calculate the failure probability of the pressurizer Code safety valves in a manner that is similar to how the licensee calculated the failure probability for the pressurizer PORVs (based on the number of actuations).

+ The pressurizer Code safety valves have not been qualified for multiple cycles of liquid reactor coolant discharge and testing that has been performed to date is insufficient to substantiate such a low failure probability (0.1) over multiple cycles of liquid reactor coolant discharge. [See related discussion in B(8)]

(5) Unprotected East and West Penetration Rooms

Because the East and West Penetration Rooms are not protected from tornado missiles, system piping that transverse these rooms and communicate directly with the RCS could be subject to tornado missile damage and consequential LOCA; and damage to other penetrations could result in containment failure.

(6) Cask Decontamination Rooms

The tornado vulnerability associated with the cask decontamination rooms was not previously recognized and allowed by the NRC, and is therefore contrary to the existing Oconee licensing basis.

(7) Cooldown to RHR System Entry Conditions

The capability to cool the plant down to residual heat removal (RHR) system entry conditions was established as a licensing-basis criterion for the Oconee units during the resolution of post-TMI Action Plan Item II.E.1.1, and the licensee failed to recognize and address this capability.

(8) UFSAR Change to Describe RCS Makeup Capability

The Updated Final Safety Analysis Report (UFSAR) description was "supplemented" by a 1990 update to explain how reactor coolant makeup would be provided following a tornado. While this supplementary information appears to be a relaxation of the licensing-basis criteria that were established for the Oconee units, the change was not submitted for NRC review and approval.

B. **Tornado mitigation deficiencies as documented in NRC Supplemental Inspection Report 50-269,270,281/02-07 dated May 31, 2002, for the three Oconee units:**

(1) <u>Loss of Auxiliary Power to the Keowee Hydroelectric Units</u>

Failure of the Unit 1 4KV buses due to tornado wind or missile effects results in a loss of the assured source of power for the Keowee auxiliary equipment, resulting in a loss of emergency power for all three units. Duke promptly implemented a plant modification to enable the operators to power the Keowee auxiliaries from the electrical output of the Keowee hydro units. Consequently, no appreciable change in core damage frequency (CDF) has resulted.

(2) Turbine-Driven Emergency Feedwater (TDEFW) Pump Cooling

A tornado-induced failure of the Unit 1 safety-related 4KV buses would de-energize the support systems (high pressure and low pressure service water cooling) for the TDEFW pump. This previously unrecognized failure mechanism resulted in an increase in CDF of about 1E(-6) per Reactor Year (RY).

(3) Operation of the Atmospheric Dump Valves (ADVs)

Damage and debris due to tornado effects could render the ADVs unavailable for SG depressurization, thereby eliminating use of the tornado-protected station ASW system for SSHR. This previously unrecognized failure mechanism resulted in an increase in CDF of about 9E(-7)/RY.

(4) Access to Valve LP-28

In the event that the borated water storage tank (BWST) is damaged by a tornado, the Oconee design basis credits operator action to align the HPI pump to take suction from the spent fuel pool (SFP) for a source of RCS makeup water. The manually operated BWST isolation valve, which is located only a few feet from the tank, must be closed to avoid diverting water from the SFP to the damaged BWST. Damage and debris due to tornado effects may render the valve inaccessible. This previously unrecognized failure mechanism resulted in an increase in CDF of about 7E(-8)/RY.

(5) Tornado-Protected Station ASW Pump Flow Control

Duke identified that there are potential run-out and flow control difficulties with the tornado-protected station ASW pump when feeding multiple SGs. Initial feeding of three or more SGs (multiple units) would place the pump in a run-out flow condition. If tornado-related damage occurred to discharge piping in the unprotected west penetration room, pump run-out conditions would worsen. Such piping damage would make it even more difficult to establish and maintain proper flow when feeding multiple SGs. In addition, the complex communications between remote locations for feeding multiple SGs would also tend to increase the failure probability. The licensee concluded that using the station ASW pump to provide SG feedwater to more than one unit was not considered credible. This previously unrecognized failure mechanism resulted in an increase in CDF of about 5E(-8)/RY.

(6) SG Tubes Differential Temperature Issue

Due to the time necessary to evaluate alternate core cooling strategies and to place the tornado-protected station ASW pump into service, the compressive SG tube stresses were calculated to exceed the manufacturer's design limits. The licensee established a new differential temperature limit of 108 °F based on initiating station ASW pump flow within 40 minutes. Duke was continuing to evaluate the effect of this new temperature limit on SG tube compressive stresses. The report did not include an estimation of the resultant change in CDF due to this deficiency. [See related discussion in A(2) and A(3)]

(7) SFP Suction for High Pressure Injection

The water inventory in the SFP was not sufficient to ensure a 24-hour mission time for a HPI pump during all conditions and the ability of the SFP to perform this function is limited. Assuming that operators could wait for nine hours before aligning the HPI pump suction to the SFP, the licensee estimated that the SFP would be unable to perform this function for about 10% of the time. This previously unrecognized failure mechanism resulted in an increase in CDF of about 6E(-7)/RY.

(8) Pressurizer Safety Valve Reseating

Design documents for the pressurizer Code safety valves did not include qualification for being able to reseat after passing 500 °F reactor coolant. Scenarios that rely on use of the tornado-protected station ASW pump for SSHR could involve a 40-minute delay in establishing feedwater flow to the SGs. During this 40-minute delay, the RCS will heat up, causing reactor pressure to increase and lift the pressurizer Code safety valves. Steam would be released initially, followed by reactor coolant. If the pressurizer Code safety valves failed to reseat when reactor pressure eventually subsided, the tornado-protected station ASW pump and HPI pump combination would not be able to maintain adequate core cooling with the continuous loss of reactor coolant through the failed open safety valves. Based on industry testing that has been completed indicating (according to Duke) that valves of the type used at Oconee could pass hot water and reseat successfully, and based on an actual event at another facility of the same nuclear steam supplier, Duke concluded that the originally assigned failure probability of the Oconee pressurizer Code safety valves to close was acceptable. Consequently, no change in CDF due to this deficiency was reported. [See related discussion in A(4)]

(9) Unit 3 North Control Room Wall

The north wall of the Unit 3 control room was not originally designed and constructed to withstand the effects of the design-basis tornado (i.e., tornado missiles and differential pressure). In the submittal dated June 18, 2003, in response to Question 21, Duke indicated that a modification would be made to enable the wall in question to withstand the necessary differential pressure loads caused by the design-basis tornado, and that the missile impact would be evaluated using the TORMIS computer code. To the extent that this condition is corrected, no change in CDF is expected.

(10) Additional Tornado Mitigation Deficiencies

Inspection Report 02-07 also indicated that the following additional limitations in the Oconee tornado mitigation strategy were identified by the licensee:

+ Postulated tornado events could cause the loss of electrical power to the battery chargers of multiple units, which would lead to a loss of the vital instrumentation that is necessary for operating the emergency feedwater (EFW) and station ASW systems. This previously unrecognized failure mechanism resulted in an increase in CDF of about 6E(-7)/RY.

+ Postulated tornado events could result in a loss of the 4160 VAC standby bus feeders that pass from the Units 1 and 2 tornado-protected block house to the Unit 3 main feeder bus. This previously unrecognized failure mechanism resulted in an increase in CDF of about 2.5E(-6)/RY.

+ Postulated tornado events could result in collective effects that fail the BWST and the west penetration room of a particular unit coupled with the failure of electrical connections between the standby and main feeder buses for multiple units. This previously unrecognized failure mechanism resulted in an increase in CDF of about 2.8E(-6)/RY.